

Special issues of initial margin calculation for certificates based on the requirements of the EMIR regulation

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Abstract

Initial margin is the part of the multilevel guarantee system, operated by central counterparties. The main goal of this guarantee system is to manage the risk caused by taking over counterparty risk from the participants during trading on stock exchanges. Based on this risk overtaking, the counterparty risk is being centralized, and concentrated at the central counterparties. The regulators have perceived this risk, and established the so called EMIR regulation in Europe in 2012. Our paper will focus on an initial margin calculation method of a European central counterparty, which is compliant with the requirements of the EMIR regulation. Our focus, will be a special type of financial asset, the certificates. We show how the initial margin calculation model should be changed, and developed in order to be able to capture the specialities of these asset.

Journal of Economic Literature (JEL) codes: G15, G17, G18


Keywords: central counterparty, initial margin, EMIR, procyclicality, certificates

1. Introduction

The role of a central counterparty is to take over counterparty risk from market participants during trading on stock exchanges. Central counterparties are part of the financial market infrastructure (FMI). *‘FMIs that facilitate the clearing, settlement, and recording of monetary and other financial transactions can strengthen the markets they serve and play a critical role in fostering financial stability. However, if not properly managed, they can pose significant risks to the financial system and be a potential source of contagion, particularly in periods of market stress.’* (CPSS-IOSCO, 2012). According to this the regulators realized that central counterparties has an important role regarding the stability of the whole financial system. To facilitate this stability the regulators have published the so called EMIR (European Market Infrastructure Regulation – 648/2012/EU) regulation in Europe in 2012, while the Dodd Frank Act (Dodd-Frank Wall Street Reform and Consumer Protection Act) in the USA in 2010. These regulations are based on the CPMI-IOSCO (CPMI: Committee on Payments and Market Infrastructure³; IOSCO: – International Organization of Securities Commissions). Not only the systematically important payment systems’ (SIPS) role was the reason to regulate the CCP-s after the crisis, but also the fact, what was stated by the G20 in Pittsburgh in 2009 that by 2012 the OTC transactions should be executed through CCP-s (FSB, 2010). It was visible that CCP-s could resist crisis ‘easily’. In the history there were only three CCP-s that went bankrupt, the Caisse de Liquidation (Paris) in 1974, the Kuala Lumpur Commodity Clearing House in 1983, and the Hong Kong Futures Guarantee Corporation in 1987 (European Commission, 2016, Hills et al. 1999).

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³ Is the same as CPSS (Committee on Payment and Settlement Systems).

Since this paper will focus on a certain initial margin model, which has created by the KELER CCP Ltd., the CCP of Hungary, so in this paper the requirements of the European regulation will be introduced regarding the initial margin calculation. The central counterparty (CCP) of Hungary, the KELER CCP Ltd. has developed a new margin calculation method in 2017, which was published by Béli and Váradi (2017). This paper is built on that model, and shows how the model should be modified in order to be able to apply it for certificates.

The initial margin is one part of the multilevel guarantee system, that a CCP should operate, based on the EMIR regulation. For example in the case of the KELER CCP, this system is the following (KELER CCP 2016):

- Basic financial collateral
- Initial margin
- Variation margin
- Supplementary collateral
- Additional financial collateral
- Collective guarantee fund

The focus of our paper is only the initial margin, so we will show only that in details. The role of the initial margin is to provide collateral for the change of the financial asset's price in normal market conditions. The initial margin model should meet the requirements of several market participants: the regulator, the traders, and the CCP itself. The most important regulatory requirement regarding the initial margin is to use a risk measure (like value at risk, or expected shortfall) with 2 days liquidation period, and on a 99% significance level, with a 250 days lookback period. Also the initial margin should contain a 25% procyclicality buffer to decrease the effect of procyclicality in the financial system (EMIR, 2012, RTS, 2013).⁴ However, CCPs must bear in mind not only the compliance with the regulatory requirements, but also the fact that they should meet the requirements of market participants. This is because market participants expect the margin to be as stable over time as possible, while effectively reflecting market developments, and should also be easily reproduced, which means that CCPs should employ few expert decisions, i.e. the margin should be determined automatically and objectively. Another crucial factor is that CCP-s use a methodology that can be applied uniformly to all products. While a CCP-s goal could be on one hand to have a stable and relatively high margin in order to manage risk efficiently. Although on the other hand a CCP would like to decrease the initial margin as much as possible in order to attract the market participants. The CCP-s are competing with one another for clients.

In the paper of Béli and Váradi (2017) they introduced an initial margin calculation method that fulfills these requirements, in case of stocks and currencies. However in case of other type of products, like bonds, or certificates, the margin cannot be calculated with the 'basic' model, since the risk factors, on which the VaR model is based are not the same.⁵ So their model should always be modified, when one want to determine margin on a product which has different risk factors, than stocks.

The study is structured as follows: Chapter 2 presents the initial margin calculation method of Béli and Váradi (2017), Chapter 3 shows how the initial margin model should be changed in case of certificates, while in chapter 4 and 5 the results of the backtest and sensitivity analysis can be found. Finally chapter 6 concludes.

⁴ In case of stock exchange transactions.

⁵ In case of illiquid and IPO products the initial margin calculation was shown by Béli et al. (2017).

2. Margin calculation method

The initial margin calculation methodology of Béli and Váradi (2017) has the following requirements in focus: 1) Meet the requirements of the EMIR regulation; 2) Follow market trends; 3) Stable margin; 4) Automated and objective procyclicality buffer management; 5) Few expert decisions.

In this paper we introduce shortly the initial margin model, since it is described in details in Béli and Váradi (2017):

- 1) *VaR determination*: The risk measure the model is using the Value at Risk, since it has the advantage compared to the Expected Shortfall, that it is easier to backtest (Acerbi and Székely, 2014; Yamai and Yoshida, 2005), it is elicitable⁶ (Ziegel, 2016; Gneiting, 2011), and fewer data are enough for reliably calibrating the model and it is not sensitive to outliers. The model applies the delta normal method for VaR calculation, which requires to assume that the assets logreturn is normally distributed. Based on this, the two parameters that are needed to calculate the VaR is the standard deviation, and the mean value of the daily logreturns (Jorion, 2007). In the case of the standard deviation, not only the equally weighted standard deviation, but the standard deviation with exponentially weighted moving average (EWMA) weighting is determined also. Standard deviation with EWMA weighting gives the currently prevailing market trends a higher weight than older trends (J.P. Morgan and Reuters, 1996). Margin computation will be based on the standard deviation with the lower value on the day concerned. This way we can avoid the immediate excessive increase of the margin value in the case of panic; however, in the case of decrease, the margin does follow the market. The formulae used are as follows:

Value at risk determined based on return:

$$VaR_t^{return} = \min(\sigma^{equal} \cdot N^{-1}(99\%); \sigma^{EWMA} \cdot N^{-1}(99\%)) \quad (1)$$

Where $\sigma^{equal}/\sigma^{EWMA}$ denotes the equally/EWMA weighted standard deviation of the logreturns, while N^{-1} stands for the inverse of the standard normal distribution's cumulative distribution function.

Value at risk determined for price in the case of logreturn:

$$VaR_t^{price} = -P_t + P_t \cdot e^{\sqrt{T} \cdot VaR_t^{return}} \quad (2)$$

Where P_t stand for the spot price of the financial asset, while T stand for the liquidation period.

Value at risk increased by liquidity- and expert buffers:

$$CCPmargin_t = VaR_t^{price} \cdot (1 + \varphi) \cdot (1 + \theta) \quad (3)$$

Where φ denotes the liquidity buffer, θ is the expert buffer. The aim of the liquidity buffer is to give an extra buffer for those assets that are traded with low market liquidity. The role of the expert buffer is to manage other appearing risks, and also to ensure that the backtest shows a 99% adequacy. Since the VaR is based on statistics and probabilities, the 99% in the backtest can be fulfilled only on expected value, so it means that sometimes it is lower, sometimes it is higher than 99%. If the model do not reach the 99% for some reason, the expert buffer can be increased.

⁶ Elicitability means whether the result derived from the degree of risk can be verified or confirmed with other estimations.

Value at risk increased by procyclicality buffer also:

$$PROmargin_t = VaR_t^{price} \cdot (1 + \varphi) \cdot (1 + \theta) \cdot (1 + \pi) \quad (4)$$

Where π denotes the procyclicality buffer. The role of the procyclicality buffer is to be able to decrease the value of the margin (with the procyclicality buffer exhaustion) in case when there is stress on the market, to help the market participants (Berlinger et al., 2017).

- 2) Procyclicality buffer management: Procyclicality buffer exhaustion is linked also to the relative values of the two standard deviations. If the EWMA weighted standard deviation is higher than the equally weighted standard deviation, the procyclicality buffer value can be exhausted, since it shows that in the last days the volatility on the market was high; conversely, the procyclicality buffer is built back. However, an additional criterion of build back is that the procyclicality buffer is not built back fully until the EWMA standard deviation drops, with a certain extent, below the equally weighted standard deviation. The following formula illustrates the buffer exhaustion and build back criterion:

$$\sigma^{EWMA} \cdot \max\left(\frac{margin_{t-1}}{CCPmargin_t}; 1\right) > \sigma^{equal} \quad (5)$$

However, in order to avoid jumps in the margin value due to buffer exhaustion and build back, we use the following formulae:

$$margin_t^{pro-exhaustion} = \max(margin_{t-1}; CCPmargin_t) \quad (6)$$

$$margin_t^{pro-build\ back} = \min(margin_t^{pro-exhaustion}; PROmargin_t) \quad (7)$$

The margin minimum value formula is produced with the combination of equations 5-7:

$$MINmargin_t = if\left(\begin{array}{l} \left(\sigma^{EWMA} \cdot \max\left(\frac{margin_{t-1}}{CCPmargin_t}; 1\right) > \sigma\right); \\ \min(\max(margin_{t-1}; CCPmargin_t); PROmargin_t); PROmargin_t \end{array}\right) \quad (8)$$

- 3) Margin band: In order to keep the margin as stable as possible, margin computation will not be based on the minimum margin value, as it would mean that changes in the VaR value would, in most of the cases, trigger changes in the margin value also. This would not serve the interests of the market. Therefore, a so-called margin band would be created. As long as the valid margin is within the margin band, margin would not be modified. The minimum margin value and maximum margin value equalling the minimum margin value plus a certain % determine the margin band. The narrower the band, the more frequent the margin modification. The formulae applied are as follows:

Maximum margin value determination:

$$MAXmargin_t = MINmargin_t \cdot (1 + \tau) \quad (9)$$

Where τ stand for the margin band.

Margin value determination:

$$margin_t = if(margin_{t-1} > MAXmargin_t; MAXmargin_t) \quad (10)$$

$$margin_t = if(margin_{t-1} < MINmargin_t; MINmargin_t) \quad (11)$$

$$margin_t = if(MAXmargin_t > margin_{t-1} > MINmargin_t; margin_{t-1}) \quad (12)$$

For each product, parameters are determined based on the backtest results. It is checked at the product level that in the backtest the expected value in the value at risk model meets the 99% level, and that the margin meets the 100% level. The objective is to set parameters that meet these requirements. Also sensitivity test should be made to see that to which parameter is the margin model is the most sensitive. Only one parameter cannot be defined by the backtest and the sensitivity analysis, namely a lookback period. The lookback period is important, because the EMIR regulation states, that the lookback period should be at least 12 months, but it should contain a stress period as well. In this paper we will not be dealing with the determination of the lookback period of certificates, since it is the same as in the case of the stock, which was introduced by Béli and Váradi (2017).

Figures 1 illustrate the margin value under this methodology if the liquidity and expert buffers are 15%, while the margin band is 25% for the most liquid Hungarian stock, the OTP. In the figure showing changes of the margin value, ‘standard deviation’ and ‘EWMA standard deviation’ values can be seen on the secondary y axis. If one want to stabilize the margin, the only thing is need to be done, is to increase the margin band. While the level of the margin can be increased or decreased by the buffers (Béli and Váradi, 2017).

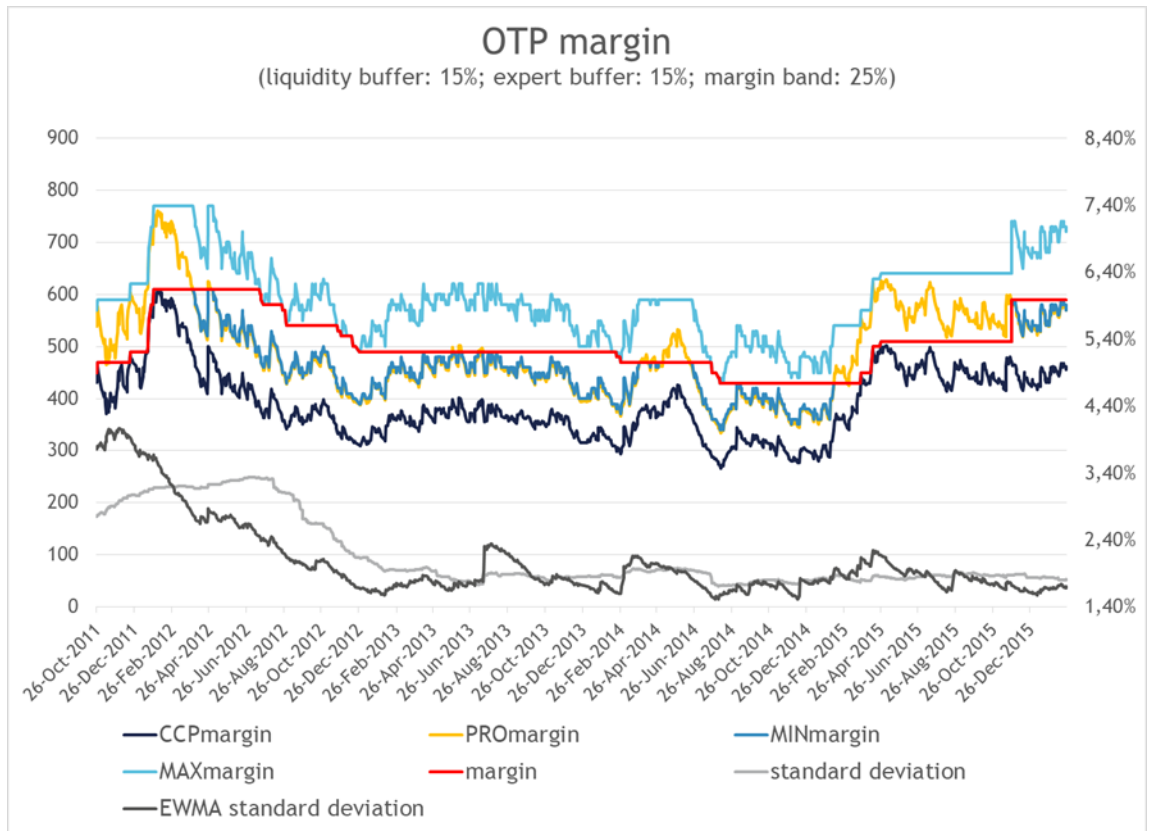


Figure 1: OTP margin value

Source: Béli and Váradi (2017)

In sum, the solutions to reach the goals are the following:

1. **Meet the requirements of the EMIR regulation of the risk measure:** Value at Risk (VaR) model with a 2 day liquidation period, with a 250 days look back period, on a 99% significance level, with the use of the extra 25% procyclicality buffer.
2. **Following market trends:** determination of the EWMA weighted standard deviation in addition to the equally weighted standard deviation in VaR calculation.
3. **Stable margin:** use of margin band.
4. **Automated and objective procyclicality buffer management:** procyclicality buffer exhaustion and build back based on the relative relationship of the two standard deviations with different weights.
5. **Few expert decisions:** A) Creation of margin groups within which parameters are standard.⁷ B) Determination of liquidity and expert buffer values based on backtest results. C) Stress definition to determine appropriately the lookback period.

Despite stating that the methodology applied to equities can also be used in the case of other products such as currencies and commodities, it is important to elaborate on how the methodology can be applied to other product groups in line with the particularities of the product concerned. In the case of equities, currencies and commodities, the risk arising from one risk factor is to be managed, however, there are a number of other products where several risk factors influence the product price, such factors cannot be ignored in margin computation. One example for a kind of product like this, are the certificates, the focus of our paper.

3. Margin calculation for certificates

The margin methodology of certificates is different from the margin methodology of equities. In addition to the risk of price change of the underlying, FX risk is to be considered also in the case of certificates with non-HUF based underlying. However, we do not manage the risk arising from FX rates change separately but consider the correlation of the two risks by determining the Value at Risk based on the yield calculated from the HUF-based price of the underlying of the certificate, and not determine separately a Value at Risk to quantify price risk and another to quantify currency risk. If the correlation of the price of the underlying and the currency rate were perfect, we would not make any mistake by doing so. However, the lower the correlation of the price change of the underlying and the currency rate change, the lower the Value at Risk in HUF, compared to considering separate Value at Risk for the two risk factors and converting their sum to HUF. For this reason, in this initial margin calculation method the correlation of the two risk factors should be monitored daily, and if the expert finds that the computed Value at Risk underestimates risk, it can increase the value of the expert buffer to manage the resulting risks.

There is another difference with certificates in the determination of $CCPmargin_t$, as there is a multiplier by product that has to be used to multiply the VaR values increased with the buffers, in line with equation 13, regardless whether the underling of the certificate is HUF-based or non-HUF-based.⁸

$$CCPmargin_t = VaR_t \cdot (1 + \varphi) \cdot (1 + \theta) \cdot \text{multiplier} \quad (13)$$

Figure 2 shows the ERSTE DAX margin under this margin methodology (liquidity buffer 10%, expert buffer 10%, margin band 25%). Figure 3 contains the same information for Erste DAX Turbo Long certificate. There is a difference in the parameters of the two product, different multipliers are applied (Erste DAX value is 0.001, Erste DAX Turbo value is 0.01).

⁷ This was not discussed in this paper in details.

⁸ The part of the formula that is new compared to the standard case is highlighted in red.

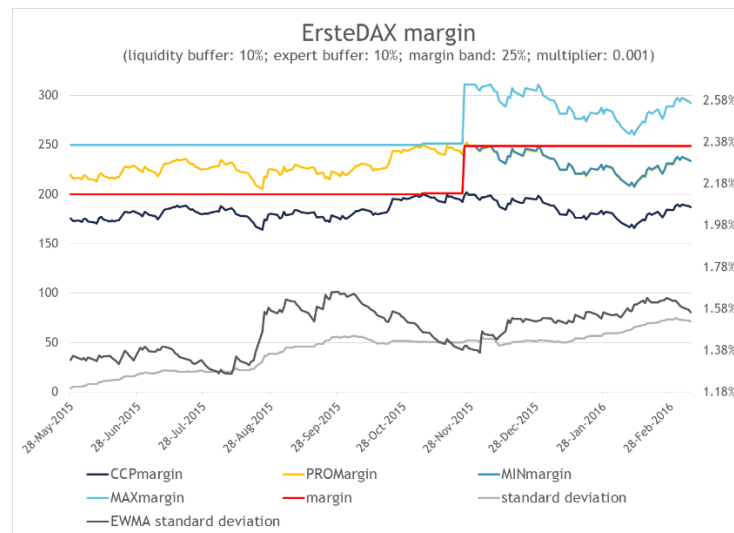


Figure 2: Erste DAX margin value

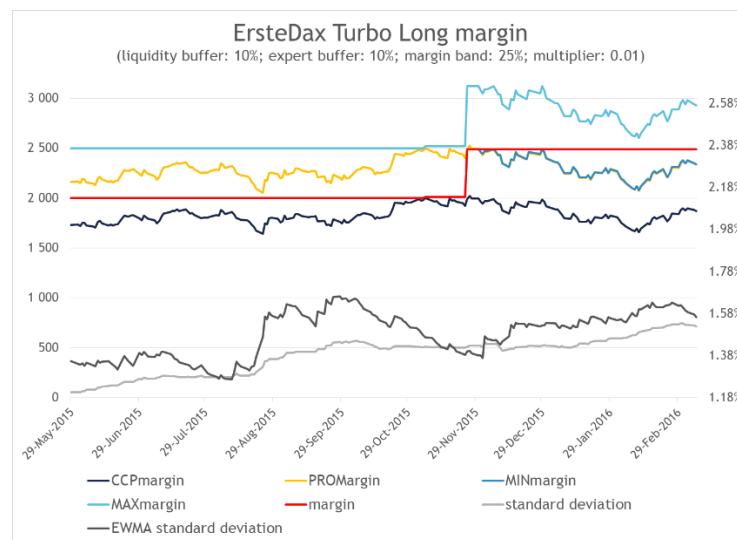


Figure 3: Erste DAX Turbo Long margin value

Changing the expert buffer is of importance in the case of certificates because of another risk factor also. In the case of turbo certificates with index underlying there is an additional risk factor also: the risk of currency interest rate change. This risk arises from the funding cost of the issuer that is built into the certificate price. In the case of long certificate, the interest rate is above the risk-free interest rate of the currency that increases the price of the certificate, in the case of short certificate the rate is below the risk-free interest rate and decreases the certificate price. However, this impact is so low and related to a small group of certificates, this is not integrated into the margin computing general methodology in the case of certificates, in order to prevent the methodology from becoming too complex, but separate expert decision can be made to increase the expert buffer. Thus, any increased risks arising due to the change of the risk-free interest rate can be managed by the new methodology.

a) Short certificates

In the case of short certificates, if the underlying is non-HUF-based, a multiplier is used to determine the margin due to the short position also. This is the '*short/long correction*' multiplier, its value is a variable

parameter in the system. This correction is required as the influence of individual risk factors – change in underlying price and change in currency rate – on the value of the certificate need to be considered. The following table summarizes the influence of changes in fundamentals, risk factors on certificate prices:

		Index certificate	Turbo long certificate		Turbo short certificate	
		Price	Price	Leverage	Price	Leverage
Price of underlying	Increase	↑	↑	↓	↓	↑
	Decrease	↓	↓	↑	↑	↓
Price of HUF in the FX of the underlying	Strengthen	↓	↓	-	↓	-
	Weaken	↑	↑	-	↑	-
FX interest of underlying	Increase	-	↑	-	↓	-
	Decrease	-	↓	-	↑	-

Table 1: Influence of changes in fundamentals on certificate value⁹

One direction price changes caused by several fundamentals at the same time represent the greatest risk. If we accept the economic premise that in global terms Hungary is a country with small economic strength and thus it does not create but ‘suffers’ major economic cycles, then it follows that short certificates represent the greatest risk for us. To justify this statement, there are two lines of thinking to consider:

1. Economic prosperity cycle: in this cycle the HUF strengthens, but at the same time indices, securities, commodities abroad also strengthen, with prices increasing. Both effects have negative impact on short certificate prices that decrease and result in a high price change. Contrary to this, the effect on long certificate prices is of the opposite direction, thus absolute price change is less. Red arrows in Table 1 show the effect of such changes.
2. Economic crisis cycle: in this cycle the HUF weakens, but at the same time indices, securities, commodities abroad also weaken, with rates decreasing. Both effects have positive impact on short certificate prices that increase and result in a high price change. Contrary to this, the effect on long certificate prices is of the opposite direction, thus the absolute price change is less. Green arrows in Table 1 show the effect of such changes.

In summary, short certificate margin will be based on the following formula:

$$CCPmargin_t = VaR_t \cdot (1 + \varphi) \cdot (1 + \theta) \cdot \text{multiplier} \cdot \left(1 + \frac{\text{short}}{\text{long}} \text{correction}\right) \quad (14)$$

It is noted that the statement that short positions carry the highest risk is not valid for all products. Therefore, expert decision is needed to determine whether short/long correction is needed. For example: the yield index of German bonds is the underlying of the EURO BUND certificates. As yield and bond price move in opposite directions, in the case of this product, in line with the above logic, long certificates mean the highest risk, thus it is recommended to apply correction of reverse direction. Figure 4 shows the Erste DAX Turbo Short margin determination, if short/long correction parameter is 5%, all other parameters remain the same as with the long example (Figure 3).

⁹ Source: http://www.erstebroker.hu/static/befrt/download/Turbo_certifikat_es_warrant_UET_151231.pdf
Downloaded: 23 March 2016

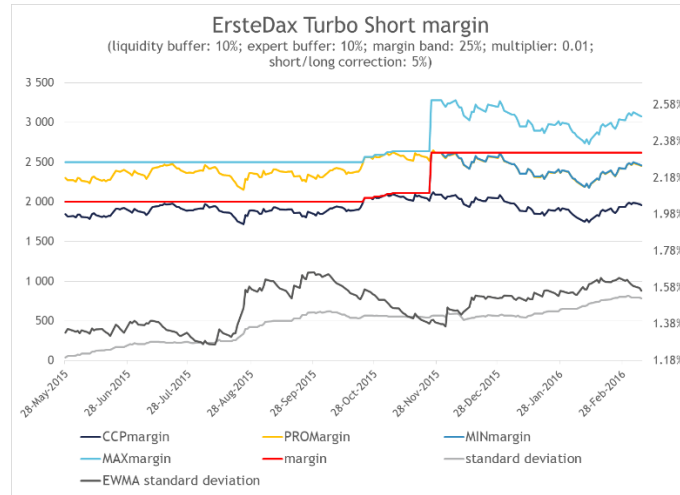


Figure 4: Erste DAX Turbo Short margin value

b) Certificate price determined in the currency of the underlying

If settlement is not in HUF but in the currency of the underlying, Value at Risk is also to be determined in the currency of the underlying, as the holder of the contract runs the risk of price change only with respect to the underlying and is not exposed to FX rate risk. However, as CCP determines margin in HUF, the risk from conversion to HUF is to be taken into account. Consequently, for this product group the formula is modified as follows:

$$CCPmargin_t = Var_t^{in FX} \cdot e^{Var_t^{FX}} \cdot FX rate_t \cdot (1 + \varphi) \cdot (1 + \theta) \cdot multiplier \quad (15)$$

As the short/long position issue that arises in the case of certificates settled in HUF does not apply to this product group, there is no need to use 'short/long correction'. Furthermore, it is worth observing that although we would expect the margin need to be less in all cases when the underlying is considered in its own currency than if it has to be converted into HUF, as we are exposed to less risk, there is no FX risk. However, when Figures 3 and 5 are compared, it can be seen that products with the highest margin are not the same. This is due to the correlation of the risk of price change of the underlying and the FX risk, thus diversification effect can arise between the two risk factors, thus driving down the margin need.

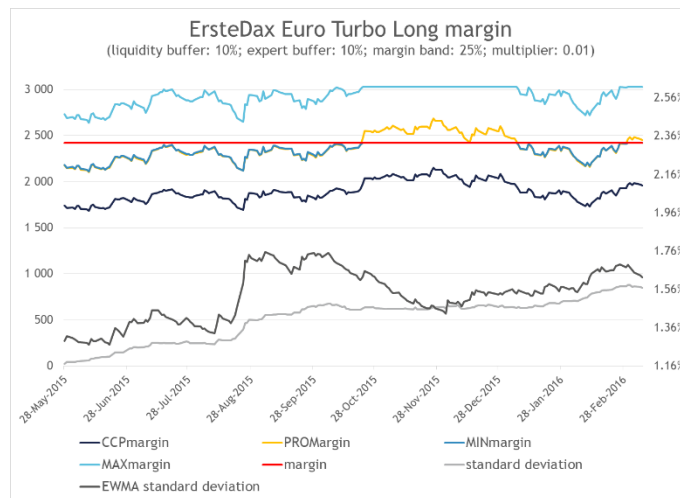


Figure 5: Erste DAX Turbo (EUR settlement) Long margin value

c) Reverse convertible and Bonus certificates

The special feature of reverse convertible (RC) and Bonus certificates is that the maximum value of payment is limited. As soon as the price of the underlying reaches a set limit, payment is made based on the performance of the underlying. However, if the underlying price does not reach the limit set, then a ‘*Bonus*’ determined in advance is paid. Therefore, the formula used for other certificate types is to be supplemented with the bonus value, as the VaR value determined on yield distribution and the margin determined based thereon will not be appropriate, as in the case of yields calculated from the possible prices of certificates, we cannot assume normal distribution. For this reason, the determination of minimum margin is modified to check what the minimum margin would be if we decided to determine the margin as if there were no Bonus in the construction, and to check the Bonus value also (in the case of these products this is a certain percentage of the nominal value). Margin computation will be based on the higher of the two values. Thus, the following formulae will be modified: VaR calculation, and $MINmargin_t$ determination (all other formulae remain unchanged).

$$VaR_t^{price \text{ (in case of Bonus, RC)}} = VaR_t^{price} \cdot \frac{\text{Nominal Value}}{P_t} \quad (16)$$

$$MINmargin_t^{RC/Bonus} = MAX(MINmargin_t; \text{Nominal Value} \cdot \text{interest}) \quad (17)$$

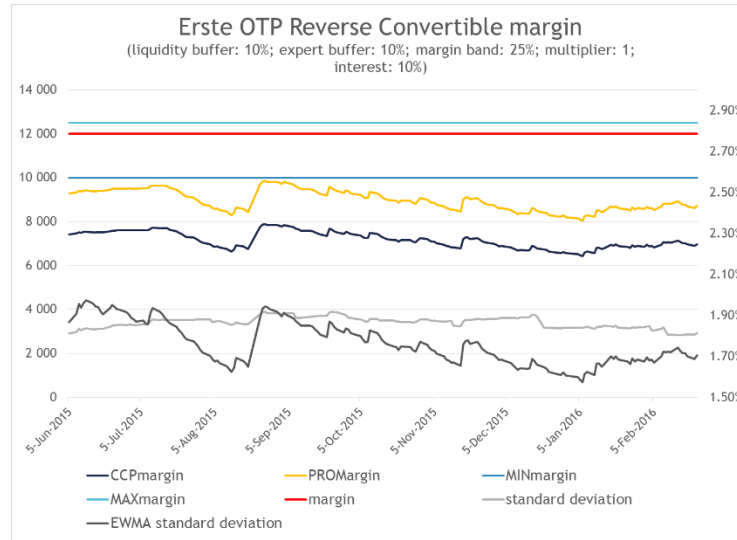


Figure 6: Erste-OTP reverse convertible margin value I.

If we decreased the interest level, the second member, i.e. the ‘*Nominal Value · interest*’ part would not always dominate in the formula to determine the minimum margin. For example: if all parameters remain unchanged and interest rate is decreased to 5%, margin would be as shown in Figure 7.

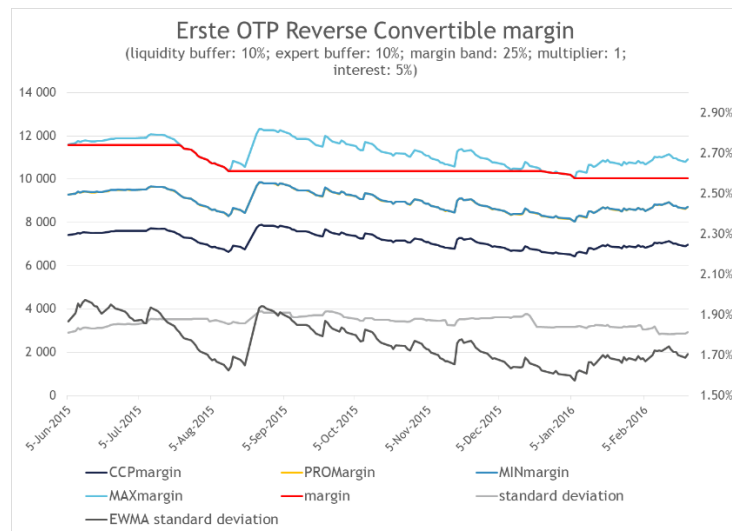


Figure 7: Erste-OTP reverse convertible margin value II.

4. Backtest

Back testing is performed in two ways for each product. On the one hand it is checked that how many times the actual daily price change exceeded the margin applied in the past 250 trading days, on the other it is checked how many times the actual daily price change exceeded the VaR value. In the case of VaR, the VaR computed with equally weighted standard deviation and the VaR with EWMA weighting are not checked separately, but always the lower value is used in the back testing, as this is the one used for margin determination also. Therefore, 99% compliance in the case of VaR will not be ensured, as we always use the lower value; however, it will be very near to 99% if the models work well and the parameters are appropriate. The objective is to achieve nearly 100% margin compliance as the buffers used should ensure that margin compliance is higher than 99%. The back testing results for all certificates are as follows:

Results			
product group	security	margin	VaR (min: equally weighted, EWMA)
Certificate (based on 200 days)	ErsteDAX	100.00%	100.00%
	ErsteDAX Turbo Long	100.00%	100.00%
	ErsteDAX Turbo Short	100.00%	100.00%
	ErsteDAX Turbo Long EUR	100.00%	99.20%
	ErsteDAX Turbo Short EUR	100.00%	99.20%
	OTP Reverse Convertible	100.00%	99.20%
	Average	100.00%	99.60%

Table 2: Back testing result

Table 2 shows that in the case of the products tested, margin compliance was always 100%, i.e. price change never exceeded the margin applied, and also the VaR based backtest was adequate, too. The following figure shows the backtest result for the Erste DAX Turbó Short.

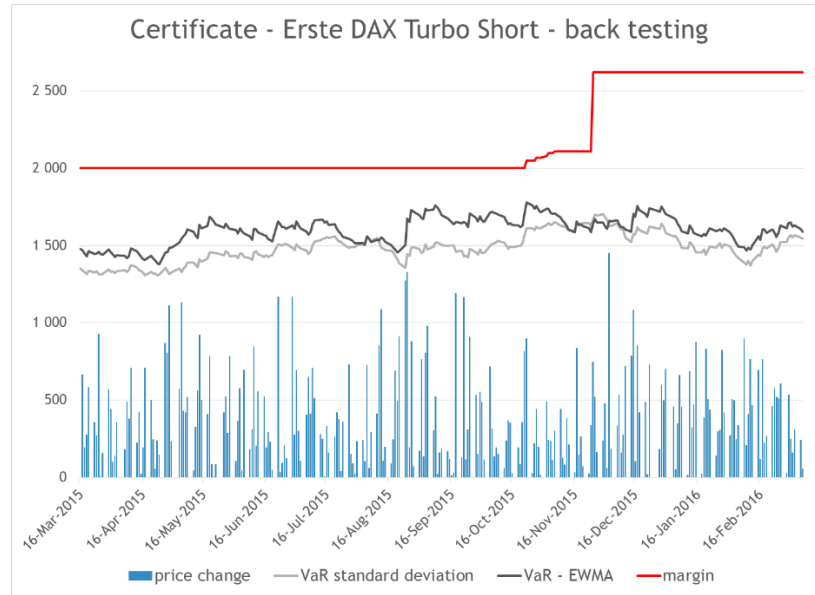


Figure 8: Certificate: Erste DAX Turbo Short back testing

5. Sensitivity analysis

The sensitivity analysis is discussed in details in Béli and Váradi (2017). In case of the certificates the methodology is exactly the same, the only difference is, that there is an extra parameter tested, namely the ‘short/long multiplier’. Shortly, the purpose of sensitivity analysis is to check, *ceteris paribus*, how the change in one parameter changes the value of the margin to be used, and how it impacts the result of the backtest. Based on this we can check if the change of parameters is the same (e.g. 1%), which parameter will have most impact on the margin and the back testing result. The test was performed on the margin values used on 30 December 2015 (last trading day in 2015). The sensitivity analysis has been carried out to the short certificate. Starting parameters were as follows: significance level 99%, liquidation period: 2 days, liquidity buffer: 10%, expert buffer: 10%, procyclicality buffer: 25%, margin band: 25%, tolerance level: 1%, short/long multiplier: 5%.

Tables 3-4 show the margin and back test results that demonstrate what was already experienced by Béli and Váradi (2017) in the case of OTP, i.e. it is the change of the significance level that the model is most sensitive to. It can be seen that the significance level could not be modified in the positive direction with more than 1% of the 99% value, as the value would exceed 100%. Furthermore, although in terms of mathematics the negative direction modification of 99% makes sense, this result does not represent material information for CCP (just like the liquidation period or the procyclicality buffer decrease), as the regulator restricts the minimum values of these parameters. It also can be seen from the results that the modification of the significance level had the most substantial impact, while even the modification of +/- 20% of the margin band and the tolerance level did not impact the margin value (same as Béli and Váradi, 2017).

Percentage change of the margin								
Original margin	VaR parameters		buffers				EWMA	multiplier
2620.00	α	T	liquidity	expert	procyclicality	band	γ	S/L
Change	99%	2	10%	10%	25%	25%	1%	5%
-20%	-65.65%	-11.07%	-1.91%	-1.91%	-4.20%	0.00%	-0.38%	-1.15%
-19%	-64.12%	-10.31%	-1.91%	-1.91%	-3.82%	0.00%	-0.38%	-1.15%
-18%	-62.60%	-9.92%	-1.91%	-1.91%	-3.82%	0.00%	-0.38%	-1.15%
-17%	-60.31%	-9.16%	-1.53%	-1.53%	-3.44%	0.00%	-0.38%	-0.76%
-16%	-59.16%	-8.78%	-1.53%	-1.53%	-3.44%	0.00%	-0.38%	-0.76%
-15%	-57.63%	-8.02%	-1.53%	-1.53%	-3.05%	0.00%	-0.38%	-0.76%
-14%	-55.73%	-7.63%	-1.53%	-1.53%	-3.05%	0.00%	-0.38%	-0.76%
-13%	-53.82%	-6.87%	-1.15%	-1.15%	-2.67%	0.00%	-0.38%	-0.76%
-12%	-51.91%	-6.49%	-1.15%	-1.15%	-2.67%	0.00%	-0.38%	-0.76%
-11%	-49.62%	-5.73%	-1.15%	-1.15%	-2.29%	0.00%	-0.38%	-0.76%
-10%	-47.71%	-5.34%	-1.15%	-1.15%	-2.29%	0.00%	-0.38%	-0.76%
-9%	-45.42%	-4.96%	-1.15%	-1.15%	-1.91%	0.00%	-0.38%	-0.38%
-8%	-42.75%	-4.20%	-0.76%	-0.76%	-1.91%	0.00%	-0.38%	-0.38%
-7%	-40.08%	-3.82%	-0.76%	-0.76%	-1.53%	0.00%	-0.38%	-0.38%
-6%	-37.02%	-3.44%	-0.76%	-0.76%	-1.53%	0.00%	0.00%	-0.38%
-5%	-33.59%	-2.67%	-0.76%	-0.76%	-1.15%	0.00%	0.00%	-0.38%
-4%	-29.77%	-2.29%	-0.38%	-0.38%	-0.76%	0.00%	0.00%	-0.38%
-3%	-25.19%	-1.53%	-0.38%	-0.38%	-0.76%	0.00%	0.00%	-0.38%
-2%	-19.47%	-1.15%	-0.38%	-0.38%	-0.38%	0.00%	0.00%	-0.38%
-1%	-11.83%	-0.76%	-0.38%	-0.38%	-0.38%	0.00%	0.00%	0.00%
0%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1%	61.83%	0.38%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2%		0.76%	0.00%	0.00%	0.38%	0.00%	0.00%	0.00%
3%		1.53%	0.00%	0.00%	0.38%	0.00%	0.00%	0.00%
4%		1.91%	0.38%	0.38%	0.76%	0.00%	0.00%	0.00%
5%		2.29%	0.38%	0.38%	0.76%	0.00%	0.00%	0.00%
6%		3.05%	0.38%	0.38%	1.15%	0.00%	0.00%	0.00%
7%		3.44%	0.38%	0.38%	1.15%	0.00%	0.00%	0.38%
8%		3.82%	0.76%	0.76%	1.53%	0.00%	0.00%	0.38%
9%		4.20%	0.76%	0.76%	1.53%	0.00%	0.00%	0.38%
10%		4.96%	0.76%	0.76%	1.91%	0.00%	0.00%	0.38%
11%		5.34%	0.76%	0.76%	1.91%	0.00%	0.00%	0.38%
12%		5.73%	0.76%	0.76%	2.29%	0.00%	0.00%	0.38%
13%		6.11%	1.15%	1.15%	2.29%	0.00%	0.00%	0.38%
14%		6.87%	1.15%	1.15%	2.67%	0.00%	0.00%	0.38%
15%		7.25%	1.15%	1.15%	4.58%	0.00%	0.00%	0.38%
16%		7.63%	1.15%	1.15%	4.58%	0.00%	0.00%	0.76%
17%		8.02%	1.53%	1.53%	4.96%	0.00%	0.00%	0.76%
18%		8.78%	1.53%	1.53%	4.96%	0.00%	0.00%	0.76%
19%		9.16%	1.53%	1.53%	5.34%	0.00%	0.00%	0.76%
20%		9.54%	1.53%	1.53%	5.34%	0.00%	0.00%	0.76%

Table 3: Certificates - margin sensitivity

The back test also shows that there is no knockout even if the parameter change is of 20% (except for the significance level, the regulator does not allow it to decrease anyway). It can be concluded from the sensitivity

analyses of the backtests that currently parameter changes in the positive direction have no influence, as the back test originally showed 100% compliance at the margin level.

Back testing								
Original result	VaR parameters		buffers				EWMA	multiplier
100.00%	α	T	liquidity	expert	procyclicality	band	γ	S/L
Change	99%	2	10%	10%	25%	25%	1%	5%
-20%	86.40%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
-19%	87.60%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
-18%	88.40%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
-17%	90.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
-16%	91.60%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
-15%	93.60%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
-14%	94.80%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
-13%	95.60%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
-12%	96.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
-11%	96.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
-10%	96.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
-9%	97.20%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
-8%	98.80%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
-7%	99.20%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
-6%	99.60%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
-5%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
-4%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
-3%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
-2%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
-1%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
0%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
1%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
2%		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
3%		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
4%		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
5%		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
6%		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
7%		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
8%		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
9%		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
10%		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
11%		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
12%		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
13%		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
14%		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
15%		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
16%		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
17%		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
18%		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
19%		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
20%		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

Table 4: Certificates – back test sensitivity

6. Summary

The purpose of this study was to show how the initial margin calculation method can be used for certificates. The specialty of the certificates compared to stocks, commodities and currencies – to which the model has been introduced by KELER CCP in 2017 in the paper of Béli and Váradi (2017) – that there are more than one risk factor in the price evolution of the financial asset. The main results were, that we have shown how the time series of the price of the certificate's underlying product should be taken into account in the model; how the multiplier – that is defined by the issuer of the certificate – has to be built into the calculation. Also our notable result was, that we have shown that in case of an emerging market, like Hungary, how the short turbo certificate position should be handled. Moreover we have shown how the margin should be defined in case of those certificates which has a pay off in another currency, than Hungarian Forint. Lastly, we have shown how the reverse convertible products' margin should be defined. With a backtest and sensitivity analysis, we have confirmed, that the initial margin model we have built is adequate for the risk management purposes.

Bibliography

- Acerbi, C. & Székely, B. (2014): *Backtesting Expected Shortfall*. MSCI working paper, 2014.
- Béli, M. & Váradi, K. (2017): A Possible Methodology for Determining the Initial Margin. *Financial and Economic Review*. 16(2), pp. 117-145.
- Berlinger, E., Dömötör, B. & Illés, F. (2017): Anti-cyclical versus Risk-sensitive Margin Strategies in Central Clearing. Corvinus Economics Working Paper, 3/2017.
- CPSS-IOSCO (2012): Principles for financial market infrastructures. Basel: BIS. April 2012.
- Dodd-Frank (2010): Dodd–Frank Wall Street Reform and Consumer Protection Act, 2010
- EMIR (2012): Regulation (EU) No 648/2012 of the European Parliament and of the Council of 4th July 2012 on OTC derivatives, central counterparties and trade repositories. Available: <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32012R0648> downloaded: 8th April, 2016.
- Erste website (2016): <http://www.erstebroker.hu/hu/certifikatok.html>
- European Commission (2016): Commission staff working document – Impact assessment Accompanying the document Proposal for a regulation of the European Parliament and of the Council on a framework for the recovery and resolution of central counterparties and amending regulations (EU) No 1095/2010, (EU) No 648/2012, and (EU) 2015/2365. Available at: <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52016SC0368&from=EN> downloaded: December 17. 2017.
- FSB (2010): Financial Stability Board: Implementing OTC Derivatives Market Reforms. Available at: http://www.fsb.org/wp-content/uploads/r_101025.pdf downloaded: December 17. 2017.
- Gneiting, T. (2011): *Making and evaluating point forecasts*. *Journal of the American Statistical Association*, Vol. 106. No. 494: 746–762.
- Hills, B. Rule, D., Parkinson, S. & Young, C. (1999): Central Counterparty Clearing Houses and Financial Stability, Bank of England Financial Stability Review, June, pp: 122–133.
- J.P. Morgan and Reuters (1996): *RiskMetricsTM – Technical Document*. New York, 17 December 1996
- Jorion, P. (2007): *Value at risk: the new benchmark for managing financial risk*. 3rd Edition, McGraw-Hill Education; New York, p. 624.

KELER CCP website:

<https://english.kelerkszf.hu/Risk%20Management/Multinet/Elements%20of%20the%20guarantee%20system/> Downloaded: 17 August 2016.

RTS (2013): Commission delegated regulation (EU) No 153/2013/EU of 19th December 2012 of the European Parliament and of the Council with regard to regulatory technical standards on requirements for central counterparties. Available at: <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:052:0041:0074:EN:PDF> downloaded: 8th April, 2016.

Yamai, Y. & Yoshioka, T. (2005): Value-at-risk versus expected shortfall: A practical perspective. *Journal of Banking & Finance*, 29(4): 997-1015.

Ziegel, J.F. (2016): *Coherence and elicibility*. *Mathematical Finance*, 26(4), October: 901–918 (Version of Record online: 3 September 2014).